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Liquidity Risk, Transaction Costs and Financial Closedness: Lessons from the Iranian and Turkish Stock Markets

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Abstract:

Purpose: We study the impact of liquidity risk and transaction costs on stock pricing in Iran, a closed market operating under a financial embargo, and compare the results with those of an important neighbouring market, namely Turkey.

Design, Methodology, Approach: We follow Liu et al. (2016) and incorporate liquidity risk and transaction costs into the traditional Consumption-based Asset-pricing Model (CCAPM) from 2009 to 2017. Effective transaction costs are estimated *a la* Hasbrouck (2009) and liquidity risk according to eight different criteria.

Findings: According to our results, both liquidity risk and transaction costs are higher in Iran, possibly due to the financial embargo. Thus, relative to Turkey, we should expect a higher increase in the CCAPM pricing performance in Iran when accounting for these two variables. Our results are in line with this expectation and indicate that adjusting the CCAPM significantly increase its pricing performance in both countries, but relatively more in Iran.

Originality: We compare liquidity risk and transaction costs in an economy under the extreme case of a financial embargo to an open, yet in other important aspects similar economy from the same region.

Keywords: Financial Embargo, transaction costs, liquidity risk, consumption risk, Asset-Pricing, financial closedness and openness.

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1. Introduction

The impact of transaction costs and liquidity risk on asset returns has been well studied across various markets. It is the main objective of this article to study the impact of these two variables on asset-pricing in a scenario of economic closedness. Our main hypothesis is that with financial closedness, liquidity risk and transaction costs should increase and become more important in explaining the variation of asset prices. As consequence, we should expect a higher relative increase in the performance of asset-pricing models when accounting for these variables in more-closed economies. Thus, we study the impact of transaction costs and liquidity risk on stock returns in Iran and compare the results to those of an important neighbouring market, Turkey. Given the restrictions that the financial embargo imposes on the financial market in Iran, we would expect transaction costs and liquidity risk to be of particular importance in the determination of Iranian stock returns.

There is no unique view in the literature on the direction and magnitude of the effects of transaction costs on asset returns and transaction volumes (Lo et al., 2004). Within a general equilibrium framework, Constantinides (1986) considered prices exogenous and calculated the optimal investment policy. He compared two risky assets, where the first was traded with a proportional transaction cost and the second without. His results indicated that these costs only influence asset returns marginally. Vayanos and Vial (1997) performed a similar type of exercise, but with endogenous prices, and found that the effect of transaction costs on returns was small, but observed a significant negative effect on trading volumes.

There is rich literature reporting that transaction costs and liquidity risk are important in the definition of securities prices and returns (e.g. Amihud and Mendelson, 1986; Heaton and Lucas, 1996 and Lo et al., 2004). Dreyer (2012) shows that both transaction costs and liquidity premium can explain at least part of the so-called Equity Premium Paradox (Mehra and Prescott, 1985). In line with this, Liu et al. (2016) use a liquidity-adjusted Consumption-based Asset-pricing Model (CCAPM) alongside different measures of transaction costs and show that the model outperforms the original CCAPM by explaining a larger fraction of the variation in cross-sectional returns.

It has been stated that more-closed economies should experience higher transaction costs and liquidity risk (see Thapa and Poshakwale, 2010; Bekaert et al., 2011 and Lee and Chou, 2018). Likewise, higher liquidity risk and transaction costs are associated with higher costs of equity and lower economic growth (Wu et al., 2010; Boubakari, 2010 and Cooray, 2010). Thus, in an extreme case of a financial embargo being in place, we should expect an economy to experience relatively higher liquidity risk and transaction costs, leading to lower economic growth and a decrease in social welfare. In this case, we could say that higher transaction costs and liquidity risk are the means through which the embargo operates.

The Iranian economy under financial embargo can be considered an excellent "laboratory" to run tests on the impact of financial closedness on transaction costs, liquidity risk and asset-pricing. Our main objective with this article is to answer the following questions: Do more-closed economies experience relatively higher liquidity risk and transaction costs compared to their peers? Do these variables impact stock returns in line with what is described by the literature? When adjusting asset-pricing models for these variables, do we see a greater relative increase in the models' ability to explain the variation of stock returns in more-closed economies compared to in others?

In order to answer these questions, we follow Liu et al. (2016) and modify the traditional CCAPM by incorporating the effects of liquidity risk and transaction costs in both the Iranian and

Turkish stock markets. The stocks of the latter country are used as the “control group”. To the best of our knowledge, this study is the first to explicitly calculate transaction costs for Iranian stocks.

The process methodology is as follows. First, we collected daily closing stock prices for the Tehran and Istanbul Stock Exchanges between 2009 and 2017. We then proxy the transaction costs by using a bid–ask spread estimator based on the highest and lowest daily prices and on Hasbrouck's (2009) effective transaction costs. Then, the effective transaction costs are estimated through the Bayesian method and by using the Markov Chain Monte Carlo approach. Since the Iranian economy is more closed than the Turkish economy because of the financial embargo in place, we would expect there to be higher estimates for liquidity risk and transaction costs in Iran. Next, we apply these estimates to the CCAPM alongside eight different criteria of liquidity risk in both countries. This allows us to evaluate both the effects of transaction costs and liquidity risk on expected returns in Iran and Turkey. Finally, we verify whether accounting for these variables relatively increases the performance of the CCAPM more substantially in Iran than Turkey.

Our results confirm both a higher level and lower volatility of liquidity risk and transaction costs in Iran relative to Turkey. They also indicate that transaction costs impact expected returns and variations in intertemporal consumption. Liquidity risk has a positive and significant effect on expected stock returns in both countries, where the liquidity-adjusted CCAPM (LCCAPM) performs better than the traditional CCAPM. This increase in performance is stronger in Iran, which is in line with our hypothesis that the more closed the economy, the more important liquidity risk and transaction costs are to asset-pricing.

The paper is divided as follows: section 2 describes the literature on the effects of transaction costs and liquidity risk on asset returns. Section 3 reflects upon our research design and its limitations. Section 4 describes the data collected as well as the types of liquidity criteria used. In section 5, the estimations are performed and section 6 checks the robustness of our results. Finally, section 7 concludes this paper.

2. Returns, Transaction Costs and Liquidity Risk

Many studies have investigated the effects of transaction costs and liquidity risk on securities' returns. Amihud and Mendelson (1986) were among the first to examine the effect of liquidity on asset-pricing. Using the bid–ask spread for US stocks over the period 1961–1980, they concluded that liquidity risk plays a fundamental role in the determination of asset returns and that even small increases in transaction costs were associated with a significant liquidity premium.

In the context of balanced models, Heaton and Lucas (1996) studied transaction costs in the presence of both aggregate and idiosyncratic shocks in the US economy from 1947 to 1990. The authors defended that transaction costs tend to decrease asset prices and thereby increase their expected returns, consequently increasing the equity premium.

Using daily data on US stocks from 1960 to 1997, Amihud (2002) showed that expected and unexpected illiquidity have positive and negative effects on returns, respectively. These effects are even stronger for portfolios of small caps. Pastor and Stambaugh (2003) constructed a measure of market liquidity for NYSE and AMEX stocks from 1966 to 1999, and showed that stocks with lower liquidity betas are associated with lower expected returns.

Lo et al (2004) introduced a dynamic model of asset prices and trading volumes in cases where economic agents face fixed transaction costs. As Amihud and Mendelson (1986), they showed that even small transaction costs can affect asset prices significantly.

Acharya and Pedersen (2005) derived a liquidity-adjusted CAPM (LCAPM). Using volume and daily returns for all common stocks listed on the NYSE and AMEX, the authors found evidence that liquidity risk affects returns. Moreover, compared to the traditional CAPM, the adjusted model had a higher explanatory power. Liu (2006) adjusted the CAPM and the Fama–French 3-factor model for liquidity premium, proposing a new liquidity measure for individual stocks listed on the NYSE, AMEX and NASDAQ from 1960 to 2003. This measure was considered important in the definition of risk. Chang et al. (2010) conducted a similar study for the Japanese market over the period 1975 to 2004. They observed a positive relation between illiquidity proxies and returns. An analogous result was found for liquidity proxies.

Corwin and Schultz (2012) examined transaction costs on international and US stocks from 1993 to 2005. They estimated bid–ask spreads based on daily highest and lowest prices. By sorting portfolios according to transaction costs, the authors observed increases in spreads during financial shocks.

Subsequently, using multiple liquidity measures, Kim and Lee (2014) considered the LCAPM in the US stock market from 1962 to 2011. They showed that investors expect higher returns for stocks with lower liquidity. By generalizing the model of Acharya and Pedersen (2005), Liu et al (2016) confirmed this for the period 1950 to 2009, and showed that information on liquidity and transaction costs significantly improved the model estimations.

Other studies have been conducted for emerging markets. Bekaert et al. (2007) considered a simple asset-pricing model using variables to proxy liquidity, the return of the market portfolio and transaction costs in 19 emerging equity markets from 1987 to 2003. They concluded that local liquidity variables are an important factor to explain expected returns. Miralles-Quiros et al. (2017) found evidence of liquidity risk impacting asset returns in Portugal from 1988 to 2013. This evidence was even stronger in the sampling time when Portugal was considered an emerging market. Lam et al. (2019) studied asset-pricing in China over the period 1994 to 2014 and concluded that liquidity risk can help explain stock returns.

A few studies have also been conducted in Iran and Turkey. For example, Yahyazadehfar and Khoramdin (2008) investigated the role of liquidity factors and illiquidity risk on excess stock returns in Iran from 2000 to 2006. They showed that the relationship between illiquidity and excess returns is negative. However, excess market returns and book-to-market ratios were proved to have a positive effect on excess returns. Yahyazadehfar et al. (2010) analyzed the relationship between stock turnover (liquidity criteria) and stock returns between 2002 and 2009 in Iran. They found a positive and significant relationship between liquidity and returns. However, for the same period and market, Salehi et al. (2011) found the opposite, a negative relationship between stock returns and liquidity. By using the bid–ask spread and shares turnover as proxies for liquidity, Badavar Nahandi et al. (2014) found a positive correlation between liquidity and stock returns in Iran from 2000 to 2006. Altay and Calgici (2019) discussed the effects of liquidity risk on asset returns in Turkey (Borsa Istanbul) from 1996 to 2018. Using the LCAPM framework, they showed that the sensitivity of asset prices to market liquidity has a positive effect on returns.

In summary, recent studies have shown that transaction costs and liquidity constitute important determinants of asset returns. However, there is no agreement in the literature on the direction of liquidity effects on stock returns. In some studies, such as Pastor and Stambaugh (2003), Kim and Lee (2014), Badavar Nahandi et al. (2014), and Altay and Calgici (2019), a positive relationship has been found; whereas others, such as Chang et al. (2010) and Salehi et al. (2011), have found the opposite.

3. Research Design and Limitations

Research Design

The main hypothesis of our investigation is as follows:

> *Transaction costs and liquidity risk are higher in more-closed economies. Thus, accounting for these variables should be of special importance in these economies, where they should affect the performance of asset-pricing models more significantly.*

In order to perform our empirical investigation in a closed economy, we chose Iranian stocks as our "treatment group" as the financial embargo in operation across the entire sample period guarantees a very high level of closedness of the Iranian stock market. We use the Turkish market as the "control group" as it is an important neighbouring market with many similarities to the Iranian market, but is more connected to international markets.

As a first step in section 4, we run a comparative analysis of the estimations of the magnitudes of transaction costs and liquidity risk in both economies. Here, we check whether the data confirm that closedness is associated with higher transaction costs and liquidity risk.

Sections 5 and 6 study if the variables affect the stock prices and also the direction of these relationships in both economies. We run estimations using both traditional and liquidity-adjusted CCAPMs according to Liu et al. (2016). As the authors, we test the robustness of our results by comparing the adjusted R^2 values of the estimations from the different models and study whether accounting for transaction costs and liquidity risk in the CCAPM increases the efficiency of our estimations relatively more in the closed economy (Iran) than in the opened economy (Turkey).

Limitations

As neighbouring countries, Iran and Turkey share many similarities. Even though Iran has a much bigger surface area, the countries' population sizes are very similar. Both countries have diversified economies relative to other regional markets. Turkey has a slightly bigger GDP, but they both have significant agricultural, industrial and service sectors that contribute to both countries' GDPs in similar proportions. However, Iran is more dependent on the exports of oil and gas. When it comes to their stock exchanges, the same diversification of the economy can be observed in both the Tehran and Istanbul Stock Exchanges, although the Iranian market operates under financial embargo. These exchanges have a high weighting of government-controlled companies. Both exchanges performed well during our sample period.

However, the Turkish stock market is much bigger in capitalization as well as much more liquid than the Iranian stock market. It also constitutes a reference market for the region as it is highly connected to the European market. During the sample period, Turkey experienced strong economic growth, and attracted substantial more foreign direct investment than Iran, which underwent an economic crisis. It is likely that some differences in the structure of the financial markets may not be just the consequences of the Iranian embargo alone. However, our research design does not control for those differences. Should they affect transaction costs and liquidity risk, such unobserved variables could lead to endogeneity problems in our estimations due to confounding factors. Moreover, the use of different estimated measures of liquidity risk as well as economic data, such as the series on consumption calculated by the respective governments, could lead to endogeneity issues due to measurement errors.

A possible solution to this problem is to check the stability of our results by crossing them with those one would find if using instrumental variables and the Generalized Method of Moments

(GMM). However, this *per se* does not necessarily prevent endogeneity in cases where we would need to account for an unknown external variable[1].

4. Data and Types of Liquidity Criteria

We collected quarterly data from March 2009 to March 2017. In Iran, data on 47 companies and annual reports were collected from the website of the Iranian Central Bank, the Rahavard Nowin Statistical Database, the Tehran Stock Exchange Technology Management and the Tehran Stock Exchange. For Turkey, data on 130 companies were collected from the Eikon Thompson Reuters database for the same period.

Sample Limitations

Our sample time period of 8.5 years is considered short and constitutes a direct restriction to our sample size. This limitation is also found in other studies of the Iranian stock market. For example, Yahyazadehfar et al. (2010) and Salehi et al. (2011) worked with sample periods from 2002 to 2009 and Badavar Nahandi et al. (2014) from 2000 to 2006.

Other data limitations arise in our study since we limit the companies in our samples to those that:

- Entered the Stock Market before 2009 and did not leave until at least 2018;
- Are not under investing and financial interventions;
- Have a positive book value;
- Do not have more than three months of transaction inactivity;
- Have stocks that are traded for at least 100 days during 9 months of activity.

[1] Lucid discussions on how to use the GMM to deal with endogeneity in CCAPM estimations and the problem of weak instruments are given by Dreyer et al. (2013, 2020).

In order to cope with these restrictions, we could try to increase our sample size by constructing portfolios that include both Iranian and Turkish stocks and then calculate our results for both countries together. Alternatively, we could use the estimation results from Turkey, which is a much bigger market, to compare with those of Iran as a sort of "robustness" check.

However, if we were to mix Turkish and Iranian stocks in the same portfolio, we would lose the possibility to analyze the singularities of the Iranian market and the bigger Turkish market would likely dominate the results. Moreover, as consequence of this restriction of comparability, it would be hard to cross reference our results with the expected effects of the embargo on transaction costs and liquidity risk. Thus, we decided to perform the analysis with two independent estimations.

4.1 Liquidity Criteria

We used eight liquidity criteria to modify the CCAPM, including two linked to the market features of companies (value and book-to-market ratio). These criteria are defined as follows:

Criterion 1: LM

Following Liu (2006), we define the standardized turnover-adjusted number of days with zero trading volumes according to[2]:

$$(1) \qquad \mathrm{LM} = \left[\mathrm{NZeros} + \left(\frac{\frac{1}{\mathrm{Turn}}}{\mathrm{Deflator}}\right)\right] * (21/\mathrm{NTDays}) \, ,$$

where, NZeros is the number of days without any trading volume during the prior month; Turn is the sum of daily turnover in the past month, where daily turnover is the ratio between the number

[2] The equation is equivalent to Equation (1) of Liu (2006) for $x = 1$ month.

of shares traded in a day and the total number of shares outstanding in the end of the day; NTDays refers to the total number of trading days in the last month, and $\mathrm{Deflator}$ is a number we choose to insure that the relation $(1/\mathrm{Turn})/\mathrm{Deflator}$ is between zero and one. In our case, we use the value of 1 billion to fit our data to this condition.

The idea of the variable Turn is to consider that a higher turnover for a specific stock indicates a higher liquidity, which is comparable to fewer days without trading. Moreover, according to Liu (2006), since the total number of trading days in a month can vary from 15 to 23 in our case, the standard coefficient of $(21/\mathrm{NTDays})$ fixes this number to 21 so that the liquidity criterion can be comparable over time.

Criterion 2: Turnover Ratio

The Turnover Ratio is the simple relationship between the total number of shares traded over a month and the average number of shares outstanding in the same period.

Criterion 3: DVOL

DVOL refers to the monetary volume of monthly transactions, expressed in billion Rials and Liras.

Criterion 4: B/M

B/M is the book-to-market ratio of equity.

Criterion 5: Size

Size is calculated by multiplying the number of outstanding shares of equity by their daily closing prices.

Criterion 6: Gopalan

The Gopalan criterion from Gopalan et al. (2012) can be calculated as follows:

$$(2) \qquad Illiq_{i,t} = \frac{1}{N_{i,t}} \sum_{j=1}^{N_{i,t}} \sqrt{\frac{|R_{ij}|}{Vol_{i,j} \cdot P_{i,j-1}}},$$

where $N_{i,t}$ refers to the number of transaction days for stock i in month t, R_{ij} refers to the stock return, $Vol_{i,j}$ refers to the transaction volume of the stock, and $P_{i,j-1}$ is the closing stock price. If a stock has a low volume of transactions and its price changes substantially, then it should have a lower liquidity.

Criterion 7: cGibbs

Developed by Hasbrouck (2009), cGibbs is a measure of the effective transaction cost, which is based on the model in Roll (1984). The Roll measure is obtained using the relation $\sqrt{-cov(\Delta p_t, \Delta p_{t+1})}$, where p is the log of the transaction price. This calculation checks for the level of negative serial correlation in returns. Even though this measure requires a negative figure for the term $cov(\Delta p_t, \Delta p_{t+1})$, the author himself found a positive covariance in almost half the cases.

As in Hasbrouck (2009), we use an extension of Roll (1984), where the basic market-factor model used for calculating the measure of effective transaction cost is as follows:

$$(3) \qquad \Delta p_t = c\Delta q_t + \beta_m r_{m,t} + u_t,$$

where $r_{m,t}$ is the market return on day t and is independent from Δq_t; p_t is the log of the trade price and q_t is the direction of the trade, which assumes the value of +1 (an order to buy) or -1 (an order to sell) with equal probability; and u_t is a residual value indicating the public information in period t and is assumed to be orthogonal to q_t. According to the author, if the trade direction indicators for the stocks are independent of each other, different values for the bid–ask spread are created.

We use Gibbs sampling to estimate the model parameters (c, σ_u^2), trade direction indicators and efficient prices. This is a repetitive process involving three steps to take for each replication. The results for this criterion are obtained using the 3 Steps of Gibbs Sampling according to Hasbrouck (2009).

Criterion 8: CSspread

We use CSspread from Corwin and Schultz (2012) to estimate the bid–ask spread given the highest (H_t) and lowest (L_t) daily prices. Higher CSspreads are associated with less liquidity. CSspreads are calculated according to the following equations:

$$(4) \qquad CSspread = \frac{2(e^{\alpha}-1)}{1+e^{\alpha}},$$

where $\gamma = \left[\ln(\frac{H_{t,t+1}^{A}}{L_{t,t+1}^{A}})\right]^2$, $\beta = \sum_{j=0}^{1}\left[\ln(H_{t+j}^{0}/L_{t+j}^{0}\right]^2$ and $\alpha = \frac{\sqrt{2\beta}-\sqrt{\beta}}{3-2\sqrt{2}} - \sqrt{\frac{\gamma}{3-2\sqrt{2}}}$.

4.2 Data Descriptive Statistics

We use domestic *per capita* consumption data on the costs of non-durable goods and services in all the estimations of our CCAPMs in real terms.

For Iran, the time series data on the real personal consumption expenditure of non-durable goods and services were taken from the Central Bank of the Islamic Republic of Iran. As a measure of the risk-free rate, we collected the interest rates on one-year investment deposits of state-owned banks, according to those registered in the reports of the Central Bank.

For Turkey, we collected data on the consumption of non-durable goods and services from the Turkish Statistical Institute (TurkStat), denominated in thousands of Turkish Liras in real terms. The risk-free rate was proxied by the three-month deposit rate for Turkey as published by the IMF (IMF-IFS Deposit Rate Turkey) denominated in Turkish Liras.

Table 1 summarizes the descriptive statistics of our measures of liquidity risk and transaction costs in both Iran and Turkey. The two measures of liquidity, as defined by cGibbs and CSspread, are also used to proxy transaction costs in all our CCAPM estimations. Notice that in both cases, Iran has higher mean values than Turkey, which indicates higher transaction costs and liquidity risk.

Moreover, the variables Geoplan, B/M, LM, Turnover Ratio, Size and DVOL are used to proxy liquidity risk. Geoplan is a measure that is very sensitive to the exchange rate, so we chose not to account for its differences. B/M and LM are lower in Iran, suggesting that Iran is more liquid than Turkey. The turnover ratio is lower in Iran, indicating a higher liquidity in Turkey. Finally, the remaining variables Size and DVOL are directly dependent on the exchange rate. We decided to be conservative and to adjust the Iranian numbers using a flat exchange rate of 4000 Rials per Turkish Lira, which actually represents a very low number for the sample period. Even in this case, both measures indicate that Iran is less liquid than Turkey.

Thus, there is a general indication that both the transaction costs and liquidity risk are higher in Iran. One could possibly argue that this could be a result of the many years of financial embargo on Iran. Should this be true, accounting for the transaction costs and liquidity risk in Iran should increase the performance of pricing models relatively more than in Turkey.

Table A1 in Appendix 1 reports the correlations between the different liquidity measures, where we can verify there were positive correlations between most of them in both countries.

Table 1 Transaction costs in Iran and Turkey

Iran										
Descriptive statistics	CSspread	cGibbs	Geoplan	B/M	LM	Turnover Ratio	Size in bil. Rials	DVOL	Size Adj. in Liras	DVOL Adj. for Liras
Mean	0.423	0.039	0.011	0.125	11.000	0.032	2,350.000	2,611,545.000	0.587	652.886
Median	0.362	0.0009	0.000	0.065	3.000	0.012	29,400.000	2,066,581.000	7.350	516.645
Maximum	0.521	3.020	0.399	2.000	441.000	0.731	12,200,000	179,952,117.000	3,050.000	44,988.029
Minimum	0.000	0.000	0.000	-0.221	0.000	0.013	825.000	1,251,667.000	0.206	312.916
Std. Dev.	0.041	0.058	0.082	0.199	33.000	0.056	753,000.000	9,981,300.000	188.250	2,495.325
Turkey										
Descriptive statistics	CSspread	cGibbs	Geoplan	B/M	LM	Turnover Ratio			Size in bil. Liras	DVOL
Mean	0.295	0.035	0.017	0.253	17.000	1.000			1,597.344	2625311.000
Median	0.299	0.001	0.009	0.084	4.000	0.364			229.210	569327.200
Maximum	0.456	2.520	0.548	0.815	511.000	2.000			44,860.050	149,000,000
Minimum	0.000	0.000	0.000	0.000	0.000.000	0.000			2.940	123,254.000
Std. Dev.	0.051	0.064	0.030	0.588	23.000	0.401			4,277.293	6,836,389.000
Difference in the means										
Difference	0.128*** (169.578)	0.004*** (4.045)		-0.128*** (-21.032)	-6.038*** (-11.527)	-1.456*** (-390.116)			-1,596.750*** (-40.880)	-2,624,658.114*** (-42.144)

Table 1 presents the descriptive statistics and the results of the tests of differences in the means (t-statistics in parenthesis) of the measures of transaction costs and liquidity risk in Iran. *, **, *** indicate significance at the 10%, 5% and 1% levels, respectively. The last two columns adjust the Iranian numbers for Turkish Liras.

5. Estimations

We estimated the liquidity-adjusted CCAPM using portfolios constructed according to the liquidity criteria and market characteristics[3]. Based on previous studies and the structure of the capital market in Iran, we observed 20 portfolios. We follow Liu and Strong (2008) to calculate the portfolios returns, which are determined by both consumption and liquidity risks. In order to estimate the beta consumption and beta liquidity, we regress the following two equations according to Acharya and Pedersen (2005) and Liu et al. (2016):

$$R_{i,t} - R_{f,t} = \alpha_{i,tc} + \beta_{R_i,c}\Delta C_t + \varepsilon_{i,t} \tag{5}$$

$$-u_{i,t} = \alpha_{i,tc} + \beta_{TC_i,c}\Delta C_t + \varepsilon_{i,t}, \tag{6}$$

where $R_{i,t} - R_{f,t}$ is the equity premium of portfolio *i* compared to the risk-free rate, ΔC refers to the growth in consumption of non-durable goods and services, and $u_{i,t}$ is the residual of the following regression:

$$tc_{i,t} = \alpha_{i,0} + \alpha_{i,1} tc_{i,t-1} + u_{i,t}, \tag{7}$$

where $tc_{i,t}$ is the transaction cost of asset *i* in quarter *t*.

Betas consumption $\left(\beta_{R_p,c}\right)$ and liquidity $\left(\beta_{TC_i,c}\right)$ are estimated via a time series regression of excess returns and liquidity changes on consumption growth as in equations (5) and (6)[4], respectively.

[3] One could argue for Iran that dividing 47 stocks into 20 portfolios could create diversification issues. We classify all the available stocks into 20 portfolios according to liquidity characteristics. For each portfolio, seven companies are selected so that portfolios could have overlapping companies. We further made the calculations for portfolios of 5 and 10 stocks, which led to very similar estimation results. These calculations are available under request.

[4] Descriptive statistics for consumption growth, beta liquidity and beta consumption can be found in Table A1 in Appendix 1.

Comparative assessments between the traditional CCAPM (Eq. 8) and the LCCAPM (Eq. 9) are performed using the following cross-sectional regressions:

$$(8) \qquad R_{p,t} - R_{f,t} = \gamma_0 + \gamma_1 \beta_{R_p,c} + \varepsilon_{p,t}$$

$$(9) \qquad R_{p,t} - R_{f,t} = \gamma_0 + \gamma_1 tc_{p,t} + \gamma_2 \beta_{R_p,c} + \gamma_3 \beta_{TC_p,c} + \varepsilon_{p,t}$$

where $R_{p,t} - R_{f,t}$ refers to the equity premium of portfolio p relative to the risk-free rate in quarter t, $\beta_{R_p,c}$ is the beta consumption, $tc_{p,t}$ is the transaction cost of portfolio p, and $\beta_{TC_p,c}$ is the beta liquidity.

Estimation Results in Iran

Table 2 reports the results for our Pooled GLS estimations of the LCCAPM (Eq. 9)[5]. It has two parts: The first one involved using CSspread to account for transaction costs, while the second one involved cGibbs. The first column indicates the criteria on which the portfolios were formed. The second, third and fourth columns are dedicated to the coefficients related to transaction cost, beta consumption and beta liquidity, respectively. In addition, the numbers in parentheses refer to the t-statistics for the coefficients.

The estimates related to transaction costs in both parts of Table 2 indicate that these are only marginally related to returns. In other words, transaction costs alone lack sufficient explanatory power to predict returns with regards to liquidity risk. This is in line with Liu et al. (2016).

[5] We also run the GMM and the Fama-MacBeth methods. However, given the similar estimations results, we chose to only report those of the GLS. Tables for the remaining estimations are available under request.

The third column reports the beta coefficients related to consumption growth. In most cases, these coefficients are positive, but not statistically significant. This indicates that consumption risk has limited power in explaining the expected returns. This result is in line with previous studies that conclude that the CCAPM lacks sufficient power to explain cross-sectional stock returns (Marquez et al., 2014).

Finally, the fourth column shows that beta liquidity is positive and significant for all the criteria, except for B/M. For example, for the Turnover Ratio alongside using cGibbs as a measure of the transaction costs, this coefficient is 6.34 with a *t-score* of 3.94. The positive coefficient indicates that the expected returns increase with increasing liquidity risk. This is in line with Khoramdin (2008), who found the same positive impact of liquidity risk on stock returns in Iran. On the other hand, our results contradict those of Yahyazadehfar et al. (2010), Salehi et al. (2011) and Badavar Nahandi et al. (2014), who all found the opposite.

Table 2 Pooled GLS estimations of the adjusted model In Iran

Panel A: CSspread as a measure of transaction costs			
Liquidity Criteria	$tc_{p,t}$	$\beta_{R_p,c}$	$\beta_{TC_p,c}$
CSspread	-9.875*** (-2.702)	4.734 (1.244)	5.443*** (2.984)
Gopalan	-8.587 (-1.622)	5.212** (2.062)	11.251*** (5.214)
B/M	-7.698 (-0.954)	5.322* (1.961)	10.705*** (4.327)
Size	-4.215 (-1.521)	2.237 (0.953)	5.235** (2.321)
LM	-4.236 (-1.621)	1.125 (1.463)	6.125*** (6.230)
Turnover ratio	2.321 (1.036)	3.807 (1.604)	5.203*** (2.963)
DVOL	-2.252 (-1.025)	1.905 (0.961)	6.953*** (3.056)
cGibbs	-2.242 (-1.627)	3.528 (1.548)	7.254*** (4.476)
Panel B: cGibbs as a measure of transaction costs			
Liquidity Criteria	$tc_{p,t}$	$\beta_{R_p,c}$	$\beta_{TC_p,c}$
CSspread	7.6329 (1.462)	-8.724*** (-5.241)	5.324** (2.125)

Gopalan	-5.235* (-1.846)	3.801 (0.985)	7.483*** (3.232)
B/M	-5.265 (-1.652)	8.536** (2.062)	-4.397 (-1.154)
Size	1.953 (0.925)	1.217 (0.762)	3.326*** (3.056)
LM	6.236 (1.236)	-1.752** (-2.013)	4.939*** (2.951)
Turnover ratio	1.152 (1.643)	4.243 (1.126)	6.341*** (3.949)
DVOL	-1.235 (-0.838)	4.306** (2.541)	4.903*** (3.616)
cGibbs	-1.380 (-0.242)	2.239* (1.850)	6.043*** (2.953)

Table 2 provides estimation results of equation (9), where the coefficient estimates appear over the t-statistics (in parentheses). *, **, *** indicate significance at the 10%, 5% and 1% levels, respectively. $tc_{p,t}$ indicates transaction costs measured either by CSspread or cGibbs, while $\beta_{R_p,c}$ and $\beta_{TC_p,c}$ are used in the regressions according to their estimations in equations (5) and (6). Each liquidity measure is used to form the different portfolios and thus is indirectly accounted for in the portfolio returns.

Estimation Results in Turkey

We follow the same procedures in Turkey; for which, Table 3 reports the LCCAPM estimates. Notice that the results for Turkey are similar to those for Iran (Table 2). The second column indicates that transaction costs are only marginally related to returns. The third column shows that in most cases, the consumption beta values are not statistically significant or positive. As a result, the traditional CCAPM lacks the power to explain stock returns in Turkey. The fourth column shows that for all the liquidity criteria, the beta coefficients related to liquidity are positive and significant. This shows the importance of accounting for liquidity risk in asset-pricing in Turkey.

Table 3 Pooled GLS estimations of the adjusted model in Turkey

CSspread as a measure of transaction costs			
Liquidity Criteria	$\boldsymbol{tc_{p,t}}$	$\boldsymbol{\beta_{R_p,c}}$	$\boldsymbol{\beta_{TC_p,c}}$
CSspread	12.511 (1.297)	12.350 (1.500)	5.794** (2.012)
Gopalan	3.662 (1.654)	-10.49661** (-2.298)	5.553*** (3.133)
B/M	6.100 (1.120)	5.584 (1.506)	7.859*** (6.121)

Size	7.110*** (4.616)	11.772* (1.756)	6.707** (2.125)
LM	-2.398* (-1.950)	3.121 (1.246)	12.299*** (8.081)
Turnover ratio	-0.951 (-0.872)	2.050 (1.115)	2.367*** (2.849)
DVOL	-8.972 (1.115)	10.274* (1.906)	5.849*** (3.235)
cGibbs	-4.178 (-1.031)	5.359 (1.548)	9.412*** (5.227)
Panel B: cGibbs as a measure of transaction costs			
Liquidity Criteria	$\boldsymbol{tc_{p,t}}$	$\boldsymbol{\beta_{R_p,c}}$	$\boldsymbol{\beta_{TC_p,c}}$
CSspread	5.126 (1.562)	-4.365** (-2.130)	6.292*** (3.216)
Gopalan	-4.326 (-1.693)*	-6.322 (-1.201)	4.322** (2.124)
B/M	2.362 (0.963)	3.033 (1.395)	5.632** (2.623)
Size	3.621 (1.450)	4.982 (1.633)	5.150*** (3.016)
LM	-5.202 (-1.621)	-4.974** (-2.062)	8.260*** (2.723)
Turnover ratio	1.326 (1.264)	7.156 (1.408)	8.050** (2.302)
DVOL	-4.104 (-1.303)	8.463* (1.709)	5.343*** (3.124)
cGibbs	-3.206 (-0.982)	4.439 (1.536)	6.329*** (3.621)

Table 3 provides estimation results of equation (9), where the coefficient estimates appear over the t-statistics (in parentheses). *, **, *** indicate significance at the 10%, 5% and 1% levels, respectively. $tc_{p,t}$ indicates transaction costs measured either by CSspread or cGibbs, while $\beta_{R_p,c}$ and $\beta_{TC_p,c}$ are used in the regressions according to their estimations in equations (5) and (6). Each liquidity measure is used to form the different portfolios and thus is indirectly accounted for in the portfolio returns.

6. Robustness Checks

As in Liu et al. (2016), we checked the robustness of our results using the adjusted R^2 values of our estimations.

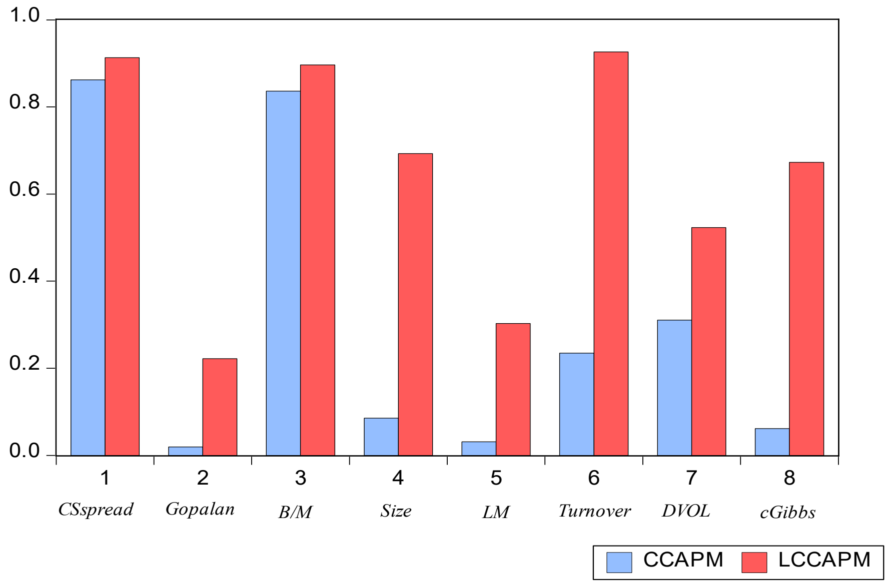
Adjusted R^2 Values in Iran

The results for our adjusted R^2 values in Iran are provided in Figure 1. Notice that the LCCAPM can explain a larger portion of the cross-sectional variance of returns than the traditional CCAPM, irrespective of the type of criterion used for the transaction costs.

For example, for the portfolios classified by the liquidity criterion Turnover Ratio, the traditional model can explain 23% and 22% of the variance in the returns when using CSspread and cGibbs, respectively, as a proxy for transaction costs. If one looks at the same liquidity criterion, but using the adjusted model, these numbers change to 92% and 62%, respectively. On average, the adjusted R^2 values for the traditional CCAPM in Iran are 30% and 16% when using CSspread and cGibbs, respectively; while for the adjusted model, these numbers are 64% and 48%, or simply put they increase relatively 113% and 200%, respectively.

Figure 1 Adjusted R^2 values for Iran

CSspread as a measure of transaction Costs



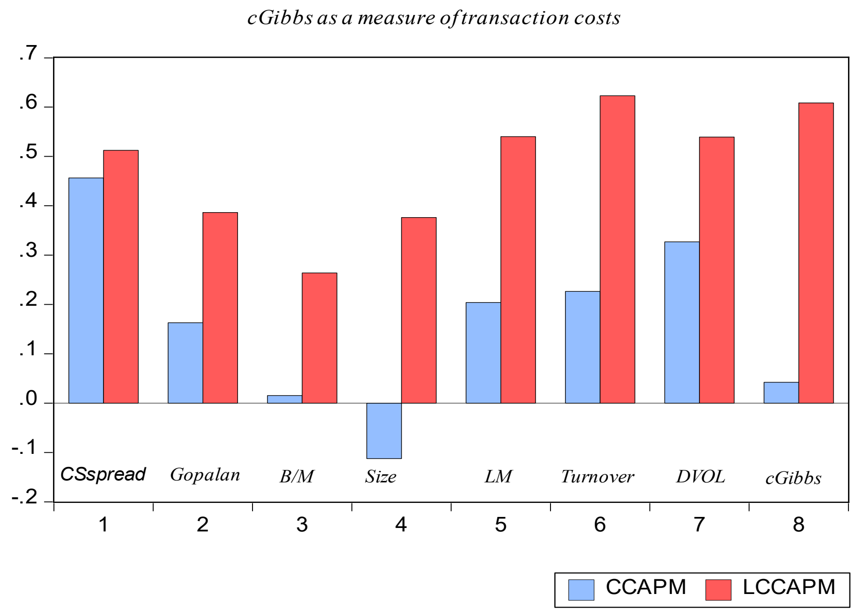


Figure 1 provides the adjusted R^2 values of the estimations of equations (8) and (9) for the traditional CCAPM and also for the adjusted one in Iran. In the first and second parts of Figure 1, CSspread and cGibbs are proxies for the transaction costs, respectively. Tests are performed on the sorted portfolios based on cGibbs, DVOL, Turnover Ratio, LM, Size, B/M, Gopalan and CSspread.

Adjusted R^2 Values in Turkey

We provide the adjusted R^2 values of the CCAPM regressions for Turkey in Figure 2. As in Iran, the adjusted models for the liquidity and transaction costs show a much better performance. The LCCAPM shows an explanatory power of 71% and 55%, respectively, according to the measure of the transaction costs used. These numbers drop to 36% and 29%, respectively, for the traditional CCAPM.

Irrespective of the model used, the average adjusted R^2 values are higher in Turkey than in Iran, indicating that the models can better fit the Turkish data compared to the Iranian. However, the increase in performance after adjusting the model is higher in Iran than in Turkey. In Iran, the average adjusted R^2 values increase relatively by 113% and 200%, respectively, depending on the measure of the transaction costs used. In Turkey, these increases are 97% and 89%, respectively.

One could say that the stronger increase in performance in Iran is in line with the main hypothesis of our investigation; i.e. that the financial embargo of Iran increases liquidity risk and transaction costs of stocks and thereby makes these two variables explain a bigger part of the equity stock premiums in Iran. Thus, for asset-pricing, it should be considered more important in Iran to take liquidity risk and transaction costs into consideration.

Figure 2 Adjusted R^2 values for Turkey

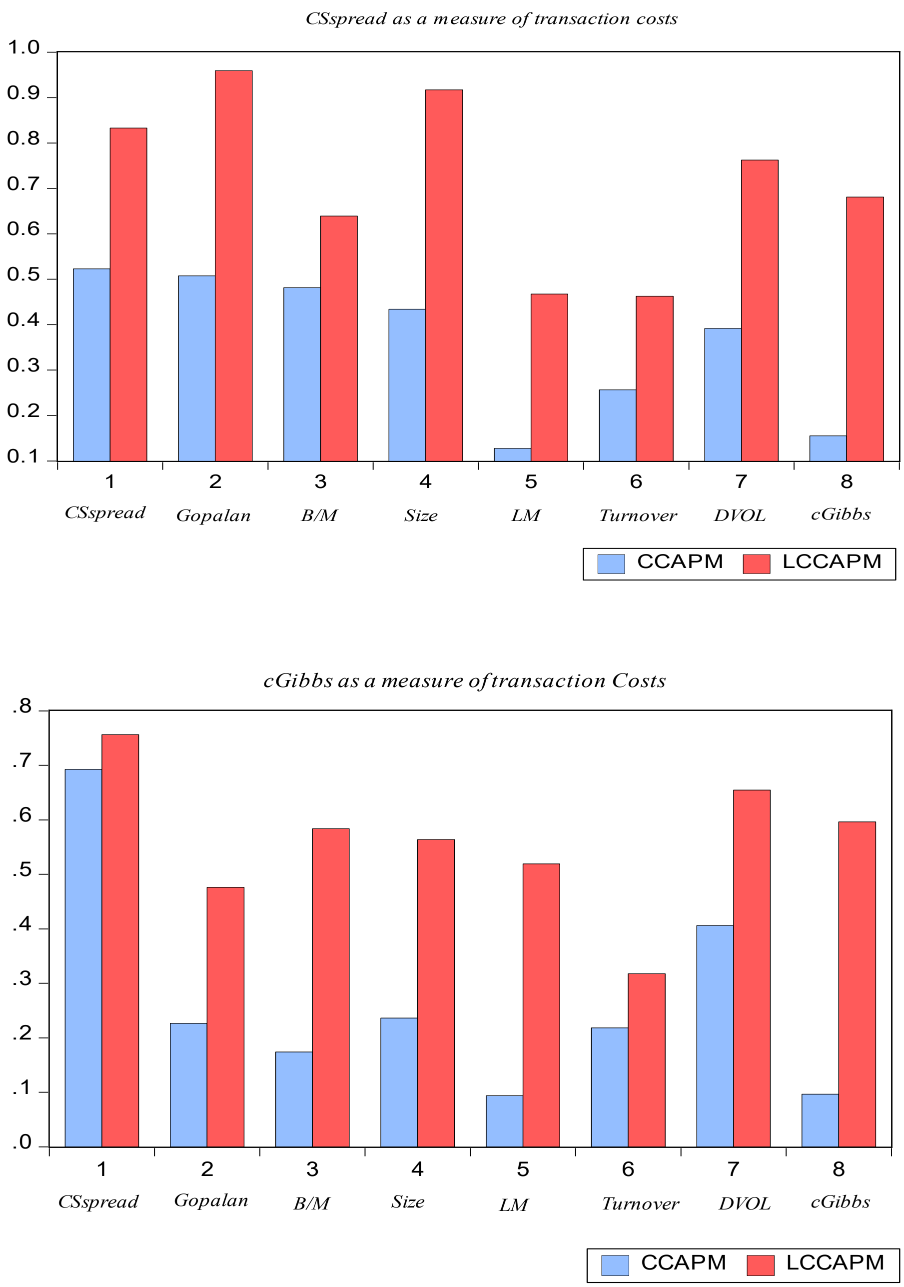
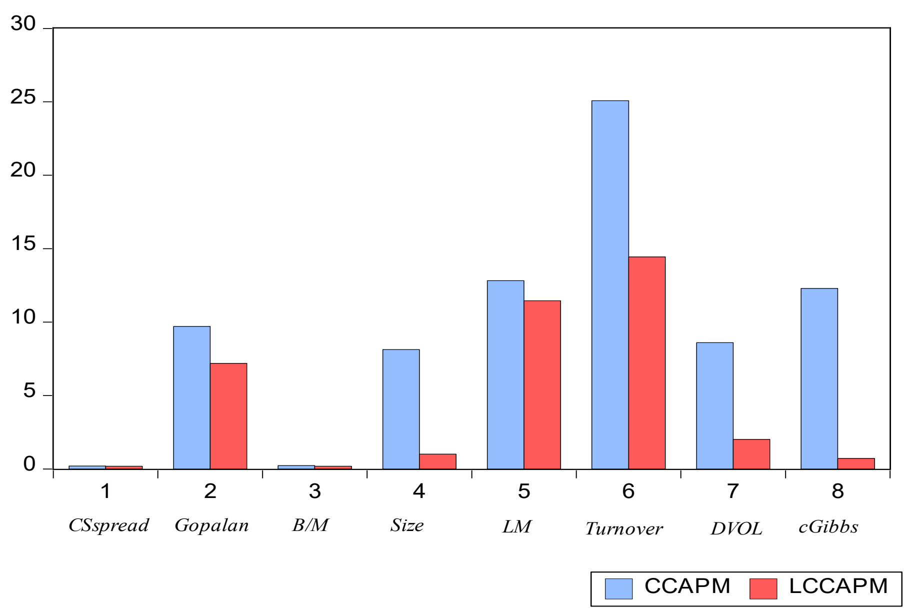


Figure 2 provides the adjusted R^2 values of the estimations of equations (8) and (9) for the traditional CCAPM and for the adjusted one in Turkey. In the first and second parts of Figure 1, CSspread and cGibbs are proxies for the transaction costs, respectively. Tests are performed on sorted portfolios based on cGibbs, DVOL, Turnover Ratio, LM, Size, B/M, Gopalan and CSspread.

Comparing Pricing Errors

Finally, we compare in both countries the pricing errors of the two models, which we define as the difference between the fitted and actual returns. We provide the average of the squared pricing errors for Iran and Turkey in Figure 3. Notice for example, that according to the results for the portfolios formed based on Gopalan, this value for the adjusted model in Iran (Turkey) is 7.19 (5.12), while for the traditional model it is 9.71 (8.15). Such figures for DVOL are 2.01 (1.01) and 8.6 (6.36). This is evidence that the pricing errors in the traditional CCAPM are larger in both countries.

Figure 3 Average of the squared pricing errors in Iran and Turkey



Turkey

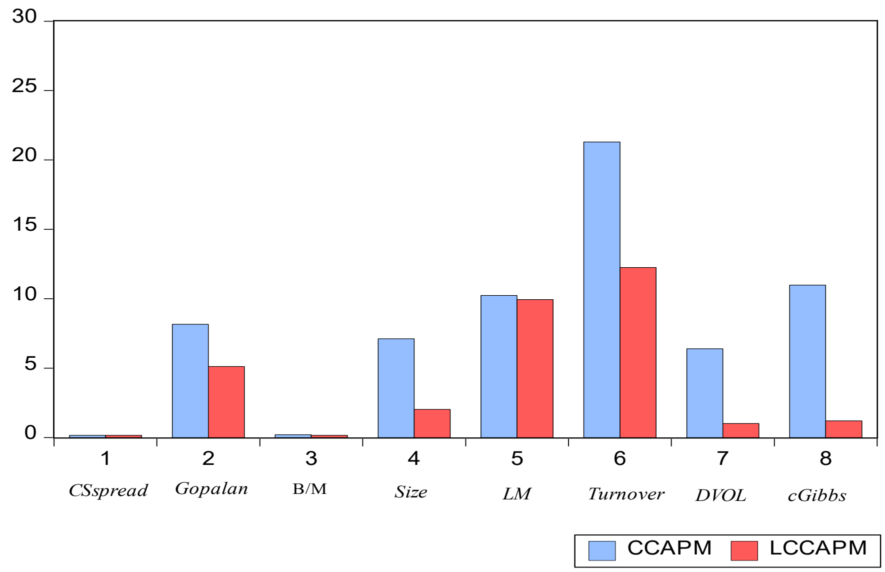


Figure 3 plots average squared pricing errors for the traditional CCAPM and the LCCAPM in Iran and Turkey. Transaction costs are proxied by the effective trading costs estimates (cGibbs) in these figures. The test portfolios are: the 20 CSspread-sorted portfolios, 20 Gopalan-sorted portfolios, 20 size-sorted portfolios, 20 B/M-sorted portfolios, 20 LM-sorted portfolios, 20 Turnover ratio-sorted portfolios, 20 DVOL-sorted portfolios and 20 cGibbs-sorted portfolios.

7. Conclusion

We studied the role of liquidity risk and transaction costs in asset-pricing in two different scenarios of financial openness by comparing Iran, a country under financial embargo, to Turkey, an important neighbouring market. In order to do so, we used an adjusted CCAPM according to Liu et al. (2016).

In line with our research hypothesis, and possibly related to the financial embargo in Iran, we found the initial estimations of transaction costs and liquidity risk are higher for Iran than for Turkey. As a consequence, we would also expect a higher increase in the performance of asset-pricing models in Iran when accounting for these variables than in Turkey. We found evidence that the inclusion of these variables in asset-pricing can improve the accuracy of the traditional CCAPM in explaining stock returns in both countries. The underperformance of the traditional CCAPM is a consequence of neglecting liquidity risk in the model estimations.

Compared to the traditional CCAPM, in both countries, the estimation results of our liquidity-adjusted CCAPM show a relative increase in explanatory power as measured by the increase in adjusted R^2 values. Thus, we conclude that the adjusted CCAPM based on liquidity criteria can explain cross-sectional stock returns better in both the Iranian and Turkish stock markets when compared to the traditional CCAPM. Moreover, one could say that this relative increase in performance is higher in Iran compared to Turkey.

As a general learning outcome, our study suggests that the degree of closedness of an economy is positively correlated with the transaction costs and liquidity risk in its financial markets. This increases the importance of accounting for these aspects in asset-pricing models. Thus, one could say that liquidity risk and transaction costs are means through which the closedness of an economy operates for asset-pricing. More specifically in Iran, they constitute one of the means through which the financial embargo operates.

Our results address several real-world and policy analysis implications; for instance, when designing policies for equity markets in emerging markets, which typically have less financial openness than developed economies (Chinn and Ito, 2008). Moreover, liquidity risk and transaction costs can be used as variables to proxy the costs of reducing the openness of an economy (intentionally or not). A good example of an intentional policy that reduces openness could be “Brexit”. Good examples of unintentional policies could be other financial embargos, such as those of Cuba, North Korea and Venezuela. Finally, a practical implication to asset-pricing is that more-closed countries should be aware of the relatively higher importance of accounting for liquidity risk and transaction costs in asset-pricing models.

Generally, our results are in line with those of many similar studies for different countries, which find that consumption risk has limited power to explain expected stock returns, while liquidity risk has a significantly positive effect on returns. Any increase in liquidity risk, including the one coming from higher transaction costs, is accompanied with a proportional increase in expected stock returns. In other words, we find evidence of an effective role of liquidity and transaction costs in asset-pricing. For Iran, these results are in line with Khoramdin (2008), who also points to the same positive impact of liquidity risk on stock returns, but are in contrast to those of Yahyazadehfar et al. (2010), Salehi et al. (2011) and Badavar Nahandi et al. (2014), who all find the opposite.

As a suggestion for future research, it is recommended to expand this analysis to other countries with high degrees of financial closedness as well as to compare the Iranian case with other important stock markets.

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Appendix 1 Descriptive Statistics

Table A1 Descriptive Statistics for Iran and Turkey

Variables	Geoplan	CSspread	B/M	LM	Size (10^7)	Turnover	DVOL	cGibbs
Spearman Rank Correlations								
Iran								
Gopalan	1							
CSspread	0.260***	1						
B/M	-0.020	0.399***	1					
LM	-0.038***	-0.256***	0.086***	1				
Size (10^7) in Rials	-0.017	0.252***	0.765***	0.260***	1			
Turnover ratio	0.145***	0.450***	0.423***	-0.159***	0.363***	1		
DVOL	0.125***	0.295***	0.395***	-0.089***	0.386***	0.699***	1	
Gibbs	-0.081***	0.085***	0.443***	-0.056***	0.303***	0.120***	0.100***	1
Turkey								
Gopalan	1							
CSspread	0.307***	1						
B/M	0.219***	0.017***	1					
LM	-0.163***	-0.326***	0.098***	1				
Size (10^7) in Liras	-0.144***	0.603***	0.428***	0.291***	1			
Turnover ratio	0.009	0.338***	0.288***	-0.215**	0.203***	1		
DVOL	0.169***	0.274***	0.252***	-0.100***	0.383***	0.492***	1	
Gibbs	-0.120***	0.072***	0.325***	-0.085***	0.412***	0.089***	0.079***	1

Descriptive Statistics of Variables used in Regressions

	Iran			**Turkey**		
Variable	Consumption growth (%)	Consumption beta	Liquidity beta	Consumption growth (%)	Consumption beta	Liquidity beta
Mean	2.42	0.61	0.19	5.28	2.09	0.55
Median	1.27	0.53	0.14	7.20	1.77	0.53
St. Dev.	16.94	1.13	0.10	16.59	13.36	0.13
Max.	33.78	2.73	0.42	33.71	10.38	1.68
Min.	-30.12	-1.20	0.08	-16.91	-0.75	0.02

The first part of Table A1 reports correlations for the 8 liquidity criteria we used to modify the CCAPM. *, **, *** indicate significance at the 10%, 5% and 1% levels, respectively. The second part provides descriptive statistics for consumption growth and for liquidity and consumption betas.